

# Econ 739 Microeconometrics

## Singapore Management University

Instructor: Yichong Zhang\*

Office location: SOE 5068

Office hours: by appointment

August 19, 2021

## 1 Course description

This course is suitable for students who intend to conduct *theoretical* research in microeconomics, causal inference, and/or high-dimensional econometrics. We first introduce the theory of empirical process and maximal inequalities, which have become the common language for econometricians. Then, we will cover the classical nonparametric estimation based on kernel and sieve methods, the convexity lemma and quantile regression, lasso, regularized quantile and logistic regressions, and causal inference with high-dimensional covariates. Basic knowledge about law of large numbers, central limit theorem, and the large sample properties of common estimators such as OLS, IV, and GMM are assumed throughout the course. The aim of the course is to provide basic knowledge for students to understand the recent theoretical econometrics papers on related topics that are published in leading journals in econometrics and statistics.

## 2 Prerequisite

ECON 611 – Econometrics, graduate level probability theory (ideally)

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### 3 Assessment

1. Problem sets: 50%
2. Final exam or term paper: 50%

### 4 Textbook

There is no required textbook. Handouts for each lecture will be made available before class. The following books are useful references for the class.

- Angrist, J. D. and Pischke, J.-S. (2008), *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton university press
- Wooldridge, J. M. (2010), *Econometric Analysis of Cross Section and Panel Data*, MIT press
- Bühlmann, P. and van de Geer, S. (2011), *Statistics for high-dimensional data: methods, theory and applications*, Springer Science & Business Media
- van der Vaart, A. W. and Wellner, J. A. (1996), *Weak Convergence and Empirical Processes: With Applications to Statistics*, Springer

### 5 Course schedule

Topic 1: Empirical process, chaining argument, symmetrization, maximal inequalities, and weak convergence

- Kengo Kato's lecture notes on empirical process (available on his website).
- van der Vaart, A. W. and Wellner, J. A. (1996), *Weak Convergence and Empirical Processes: With Applications to Statistics*, Springer, Chapter 2.
- Chernozhukov, V., Chetverikov, D., and Kato, K. (2014), "Gaussian approximation of suprema of empirical processes," *The Annals of Statistics*, 42, 1564–1597.

Topic 2: Kernel- and sieve-based nonparametric estimation

- Chen, X. (2007), "Large sample sieve estimation of semi-nonparametric models," *Handbook of econometrics*, 6, 5549–5632.

- Li, Q. and Racine, J. S. (2007), *Nonparametric Econometrics: Theory and Practice*, Princeton University Press.

Topic 3: Convexity lemma, quantile regression

- Pollard, D. (1991), “Asymptotics for least absolute deviation regression estimators,” *Econometric Theory*, 7, 186–199.
- Kato, K. (2009), “Asymptotics for Argmin Processes: Convexity Arguments,” *Journal of Multivariate Analysis*, 100, 1816–1829.
- Koenker, R. and Bassett Jr, G. (1978), “Regression quantiles,” *Econometrica*, pp. 33–50.

Topic 4: Lasso, regularized quantile regression, and regularized logistic regression

- Bühlmann, P. and van de Geer, S. (2011), *Statistics for high-dimensional data: methods, theory and applications*, Springer Science & Business Media.
- Belloni, A. and Chernozhukov, V. (2011), “ $\ell_1$ -penalized quantile regression in high-dimensional sparse models,” *The Annals of Statistics*, 39, 82–130.
- Belloni, A., Chernozhukov, V., Fernández-Val, I., and Hansen, C. (2017), “Program Evaluation with High-dimensional Data,” *Econometrica*, 85, 233–298.

Topic 5: Causal inference with high-dimensional covariates

- Belloni, A., Chen, D., Chernozhukov, V., and Hansen, C. (2012), “Sparse models and methods for optimal instruments with an application to eminent domain,” *Econometrica*, 80, 2369–2429.
- Belloni, A., Chernozhukov, V., and Hansen, C. (2014), “Inference on treatment effects after selection among high-dimensional controls,” *The Review of Economic Studies*, 81, 608–650.
- Belloni, A., Chernozhukov, V., Fernández-Val, I., and Hansen, C. (2017), “Program Evaluation with High-dimensional Data,” *Econometrica*, 85, 233–298.

## 6 Academic integrity

All acts of academic dishonesty (including, but not limited to, plagiarism, cheating, fabrication, facilitation of acts of academic dishonesty by others, unauthorized possession of exam questions, or tampering with the academic work of other students) are serious offences.

All work presented in class must be the student’s own work. Any student caught violating this policy may result in the student receiving zero marks for the component assessment or a fail grade for the course. This policy applies to all works (whether oral or written) submitted for purposes of assessment.

Where in doubt, students are encouraged to consult the instructors of the course. Details on the SMU Code of Academic Integrity may be accessed at <http://www.smuscd.org/resources.html>.

## 7 Accessibility

SMU strives to make learning experiences accessible for all. If students anticipate or experience physical or academic barriers due to disability, please let the instructor know immediately. Students are also welcome to contact the university’s disability services team if they have questions or concerns about academic provisions: [included@smu.edu.sg](mailto:included@smu.edu.sg).

## 8 Emergency Preparedness for Teaching and Learning (EPTL)

Where there is an emergency that makes it infeasible to have classes on campus, classes will be conducted online via WebEx, with no disruption to the schedule. To familiarise students with the WebEx platform, part of this course may be conducted online. The instructor will inform students of which classes, if any, will be conducted as part of this EPTL initiative.

## References

- Angrist, J. D. and Pischke, J.-S. (2008), *Mostly Harmless Econometrics: An Empiricist’s Companion*, Princeton university press.
- Belloni, A. and Chernozhukov, V. (2011), “ $\ell_1$ -penalized quantile regression in high-dimensional sparse models,” *The Annals of Statistics*, 39, 82–130.
- Belloni, A., Chen, D., Chernozhukov, V., and Hansen, C. (2012), “Sparse models and methods for optimal instruments with an application to eminent domain,” *Econometrica*, 80, 2369–2429.
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- Belloni, A., Chernozhukov, V., Fernández-Val, I., and Hansen, C. (2017), “Program Evaluation with High-dimensional Data,” *Econometrica*, 85, 233–298.
- Bühlmann, P. and van de Geer, S. (2011), *Statistics for high-dimensional data: methods, theory and applications*, Springer Science & Business Media.
- Chen, X. (2007), “Large sample sieve estimation of semi-nonparametric models,” *Handbook of econometrics*, 6, 5549–5632.
- Chernozhukov, V., Chetverikov, D., and Kato, K. (2014), “Gaussian approximation of suprema of empirical processes,” *The Annals of Statistics*, 42, 1564–1597.
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- Pollard, D. (1991), “Asymptotics for least absolute deviation regression estimators,” *Econometric Theory*, 7, 186–199.
- van der Vaart, A. W. and Wellner, J. A. (1996), *Weak Convergence and Empirical Processes: With Applications to Statistics*, Springer.
- Wooldridge, J. M. (2010), *Econometric Analysis of Cross Section and Panel Data*, MIT press.